REMARKS/ARGUMENTS

Applicant has made amendments to the specification and claims as requested by the Examiner for purposes of correcting typographical errors and other matters of form.

Claims 1-7, 13, 22-23, and 26-36 remain in the application, the other claims having been withdrawn in response to a request for restriction, which Applicant timely traversed.

As will be explained more fully below, the Examiner has applied an incorrect definition to a critical term used by Applicant in the specification and claims and, in so doing, has misapplied the prior art.

Claim Rejection—35 U.S.C. § 112

Claim 6 has been rejected under 35 U.S.C. 112 for the reasons stated in the Office Action. In explaining the rejection, the Examiner referred to the "eye-point" (49 or 51) as shown in Fig. 6.

Applicant will demonstrate that the Examiner's understanding and use of the term "eye-point" is inconsistent with the definition specified by Applicant.

At page 1 of Applicant's description, between lines 28 and 34, the term "objective aperture" is defined to mean the objective lens aperture and any aperture at a plane conjugate to the objective lens aperture. It is well known to those skilled in the imaging art that the image of a specimen at an objective lens aperture appears at planes conjugate to the objective lens aperture.

At page 10 of the description, between lines 15 and 22, Applicant, in

describing a typical optical system using Köhler illumination and having an objective lens with an objective lens aperture, points to a number of apertures in the system that are conjugate to the objective lens aperture and which, according to the definition at page 1 of the description, are each referred to as an "objective aperture." In order that this point be crystal clear as it relates to an eye-point, the description has been amended to specifically state that an eye-point is at an objective aperture (conjugate plane to the objective lens aperture). This point is not new matter, since, at page 8, lines 19-20, it is stated "other objective apertures occur in the microscope at light sources 47 and 48, as well as at the eye-point 49 of phototube 50 and the eye-point 51 of eyepieces 55."

The eye-point is typically that place in an optical path where a viewer's eye is located. Since a viewer's eye has a lens of its own, the image at the eye-point is further focused by the observer's eye lens. Because the observer's eye focuses the image at the eye-point, the image at the eye-point, as at every other conjugate objective aperture, is not in focus as it is at an image plane. This point is essential to understanding Applicant's invention relative to confocal microscopes. It not only distinguishes the invention from the prior art which the Examiner has cited (as will be more fully discussed below), but, more importantly, provides Applicant's invention with capabilities which are novel to Applicant's invention and not within the capabilities of any confocal microscope.

With the foregoing in mind, Applicant respectfully submits that claim 6

is not deficient in terms of 35 U.S.C. 112. Claim 6, which is dependent on claim 2, which is dependent on claim 1, is directed to an improvement in an optical system for viewing an object, which improvement is a "means continuously changing the portion of the objective aperture through which light passes." Claim 6 further describes the improvement (mean) as being located at an eye-point of the imaging system. The fact that the eye-point is at a location in space is not uncommon in optics. While, in a typical system, an eyepiece would be placed at the eye-point, Applicant's claimed invention instead locates the "means continuously changing the portion of the objective aperture through which light passes" at that point. Put somewhat differently, the optical system describes the environment in which the improvement operates and the eye-point is the location where the improvement is disposed.

Applicant submits that the clarification of the meaning of "eye-point" merits the Examiner's favorable reconsideration of the rejection of claim 6 under 35 U.S.C. 112.

Claim Rejections—35 U.S.C. § 102

Claims 1-7, 13, 22-23, 26-29 and 31 all stand rejected under 35 U.S.C. 102(b) as being anticipated by Kuo et al., USPN 5,351,152 ('152 Patent).

The '152 Patent is directed to improvements in a confocal microscope using a Nipkow disk located at an image plane.

Once again, the failure to apply Applicant's express definition of "eye-point" as a conjugate aperture to the objective aperture leads the Examiner to improperly characterize the '152 Patent as anticipatory.

The Examiner has made the assumption that the eye-point is "any point at which the eye could view a focused image." As defined in the description, "eye-point" means an aperture which is conjugate to the objective aperture—where the image is not focused. It is at an objective aperture that the lens of the human eye is placed in order to see an image. But it is the lens in the human eye that focuses the image because, at the eye-point, the image is out of focus. It is well known that the place in an optical system that contains the in-focus image is the image plane or specimen plane and planes conjugate thereto. Such planes are depicted in drawings where the rays describing a beam are narrowest. Where the rays are the widest, the beam is out of focus.

With the foregoing in mind, the spinning aperture disk (170) of a confocal microscope such as shown in the '152 Patent is positioned at an image plane, not an aperture plane, as called for in the claims. An image plane and an objective plane are physically and optically different. The tiny apertures in a confocal microscope are placed at the image plane or specimen plane. Each aperture in disk 170 at that plane can only "see" a very tiny portion of the specimen. That is why it requires thousands of apertures in the disk 170 to scan the entire image. The apertures in a confocal microscope reject the out of focus light and produce an image with a very thin depth of focus.

In the present invention (as specified in the claims), the dynamic aperture mask (means continuously changing the portion of the objective aperture through which light passes) is placed at an objective aperture plane of

the optical system; thus, a single aperture is sufficient to capture the entire image instantly, without the need for scanning the mask. The purpose of the mask in the present invention is to increase the depth of focus (rather than decrease the depth of focus, as occurs in the '152 Patent) and to change the apparent angle of view. Spinning the disk 170 in the '152 Patent system does not change the angle of view.

If the spinning disk of the '152 Patent were located at an aperture plane, as opposed to an image plane, there would be no affect as described by the '152 Patent, other than darkening the image (severely reducing the illumination).

The disk 174 in the '152 Patent contains microlenses disposed slightly before the image plane so that the lenses focus the light source onto each of the many apertures of disk 170 that are placed at the image plane. Again, each aperture of disk 170 images only a tiny portion of the specimen at a time in order to build up a scanned image of the entire specimen.

By placing the aperture mask of the present invention at a plane conjugate to the objective aperture (at an objective aperture), an image of the entire specimen is presented to the mask aperture, regardless of the portion of the objective aperture through which the light passes. In other words, even though a portion of the objective aperture is masked, the entire image of the specimen is nonetheless ultimately viewable.

The benefits of the claimed combination of elements of Applicant's invention are set forth in the description and those benefits do not accrue to the '152 Patent system. The Examiner's reference to the spinning disk in the

'152 Patent as being at the objective aperture is simply incorrect, both in terms used by the '152 Patent and the clear definition of "objective aperture" as set forth in Applicant's description.

In addition, to give proper weight to the distinction between an objective aperture plane and an image aperture plane, the Examiner has also failed to give full consideration to the meaning of the phrase "dynamic aperture mask," as it appears in claims 7, 13, 23, 35-36 and claims dependent thereon.

The Examiner's attention is directed to page 7, lines 15-18, wherein the term "dynamic aperture mask" is defined. The definition includes that the mask "move relative to the objective aperture at which it is located." The functional benefits of a dynamic aperture mask are explained at lines 23-28 on page 7.

Applicant is confident that when the Examiner re-evaluates the prior art references with the appreciation of the difference between an "objective aperture" (plane) and an image aperture (plane), the allowability of the rejected claims will become evident.

Claims 1-6 are rejected under 35 U.S.C. 102(e) as being anticipated by Hayashi (USPN 6,028,306 - '306 Patent).

Once again, the Examiner has made the assumption that the spinning disk of the confocal microscope described in the reference resides at an objective aperture when in fact it is, of necessity, located at an image aperture where the image of the specimen is in focus. All of the arguments set forth above in connection with the '152 Patent are equally applicable to this

rejection, as they are to any prior art directed to confocal scanning microscopes.

In a confocal scanning microscope, it is essential that the spinning disk be at an image aperture, since only a focused beam can pass through the tiny holes of a Nipkow disk. Whereas a confocal scanning microscope builds an image bit by bit and with very little depth of field, Applicant's invention uses an entire image of the specimen and rotates the mask, not for the purpose of building the image, but rather for the purpose of changing the apparent angle of view of the image, which not only allows a 3-D image to be seen, but also produces an image with a significant depth of field.

Applicant has, throughout the claims, distinguished his invention from the technology of confocal microscopy by specifying that the dynamic aperture mask be located at a plane conjugate to the objective aperture, and not at an image plane. Applicant's dynamic aperture mask at an objective aperture and the prior art's spinning disk at an image aperture are not equivalent, do not perform the same function, and do not produce the same result.

The Examiner's rejection of claims 1-7 under 35 U.S.C. 102(e) as being anticipated by George, USPN 6,036,067, is subject to the arguments set forth above with regard to the '306 Patent and the '152 Patent and for all of the same reasons is an improper basis for rejecting those claims.

Claims 1-2 and 5 are rejected under 35 U.S.C. 102(b) as anticipated by Mundkur, USPN 3,671,754. The arguments set forth above regarding the inapplicability of confocal scanning microscopes having a moving disk at an

image plane apply equally to the Mundkur reference. The Examiner's attention is directed particularly at Col. 1, Line 9, which states "a moving scanning aperture which traverses an image field." Once again, the image field or image plane is where the image is in focus, whereas Applicant has placed his mask at an aperture plane where the image is not in focus. The results are dramatic and different. Because the dynamic aperture mask is located at an objective aperture, an image of the mask does not appear at the image plane where the image is in focus.

Claims 1-7 have been rejected under 35 U.S.C. 102(b) as being anticipated by Kino et al. (USPN 4,927,254). Once again, the same arguments as set forth above apply to the confocal microscope disclosed in the reference where multiple apertures in a spinning disk are conjugate to the specimen plane, not the objective aperture plane. This is made evident by the placement of the disk adjacent to the field lenses where the ray bundles come to a focus.

Claims 13 and 30 have been rejected under 35 U.S.C. 103(a) as being unpatentable over Kuo et al. in view of Mundkur.

Applicant respectfully submits that the inapplicability of Kuo makes the rejection improper and based on an improper and ineffective combination.

As set forth above, the Kuo reference is not anticipatory and, therefore, any combination with that reference would not result in Applicant's invention.

CONCLUSION

By rotating an off-axis aperture in a mask at an object aperture in an imaging system, Applicant is able to produce a dynamic 3-D image of a specimen with significant depth of field. The essence of Applicant's invention is the continual changing of the off-axis portion of an objective aperture through which a light beam passes in order to achieve the results set forth above. By contrast, a confocal microscope places a spinning disk with hundreds or thousands of tiny pinholes at an image plane to create a scanned image at one plane of a specimen. Whereas, in Applicant's invention, the entire image of the specimen is present at the aperture of the mask, regardless of the radial location of the mask. In a confocal microscope, only a small portion of the image of the specimen is seen through any one of the many apertures in the rotating disk at the image plane. A confocal microscope cannot produce real-time 3-D imagery, whereas Applicant's invention does.

In the claims, Applicant has carefully specified that an aperture mask is located at an objective aperture in the imaging system. The specification clearly sets forth the definition of an objective aperture as being an aperture at a plane conjugate to the objective aperture and includes specifically among such planes the eye-points of a microscope.

Accordingly, Applicant has set forth in the claims those elements of his invention which distinguish it from the prior art and which imbue the invention with the advantages over the prior art fully set forth in the description, as well as in this response.

Based on the foregoing, Applicant respectfully submits that the claims are allowable and requests an action consistent therewith.

Respectfully submitted,

Dated 3/03/03

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VERSION WITH MARKINGS TO SHOW CHANGES MADE

In the Specificati n:

Paragraph beginning at page 4, line 4, has been amended as follows:

Figure 2~~b~~a is the lens of Figure 1a with the mask of Figure 2 disposed at the aperture;

Paragraph beginning at page 4, line 14, has been amended as follows:

Figure 5a is an embodiment of a mask of the present invention formed from an L~~C~~ED matrix;

Paragraph beginning at page 8, line 15, has been amended as follows:

Referring to Figure 6, a typical optical system using Köhler illumination for imaging an object is a microscope 41 having an objective lens 42 with an objective lens aperture 43, and a condenser lens 44 having an aperture 46 which is conjugate to the objective lens aperture 43, and according to the definition used here, an objective aperture. Other objective apertures occur in the microscope at light sources 47 and 48, as well as at the eye-point 49 of phototube 50 and the eye-point 51 of eyepiece 55. Another objective aperture 52 is located in the optical system through relay lenses (not shown). As referred to herein, an "eye-point" is the location where a viewer's eye would be located to view the image of the object 53. Because an observer's eye has a focusing lens, the image is not in focus at the eye-point. The eye-point is one of the apertures conjugate to the objective aperture where the image is not in focus.

Paragraph beginning at page 13, line 12, has been amended as follows:

A number of other mechanical and electro-mechanical devices are capable of creating a variable-size aperture in a dynamic mask, such as mask 144. Details of such other mask configurations are set forth in my copending application serial no. 09/715,636, for Method and Apparatus for Creating Real-Time 3-D Images and Constructing 3-D Models of an Object Imaged in an Optical System, filed November 17, 2000. In particular, instead of overlapping opaque semi-circular members 147 and 148, the space within ring 146 could contain overlapping blade structures, such as shown in Figs 21 and 21a, which can be adjusted to create a variable-size aperture 151. Referring to Figure 22, a bellow-type expandable opaque mask 150 can also create a variable-size aperture 151. Similarly, liquid crystal diodes (LCDs), such as sown in Figs 23a, 23b and 23c, can be used to create a variable light-passing aperture 151 within ring 146. Fig 23a illustrates a circle formed by eight equal sector-shaped LCDs 154, all conditioned to pass light. In Fig. 23B, two adjacent

LCDs 154 have been conditioned to be opaque to light so that the remaining LCDs form a sector-shaped aperture that passes light. Fig. 23C illustrates the LCDs 154 conditioned such that only two adjacent sectors pass light to create an aperture 151 different in shape than that of Fig. 23b. The particular variable-shaped rotatable aperture mask 144 illustrated in Figs. 23A, 23b and 23c is but an example of the shaped that can be formed using LCDs. The advantage to using LCDs is that any shape can be achieved and quickly changed to any other shape, including shapes that would be difficult, if not impossible, to achieve with physical masks. In addition, the shapes and their transitions can be computer-created and controlled to create dynamic apertures tailored to specific needs. In addition to sector-shaped LCDs, a mask can be formed from an X-Y array of LCDs that can be switched to create any shape desired that can be moved continuously so that light can be caused to continuously move through a different portion of an objective aperture. See Kley patent 4,561,731.~~S~~

In the Claims:

Claim 27 has been amended as follows:

27. (Amended) The method of claim 22 wherein the imaging system is a light microscope having an illumination path including ~~at least one~~ the objective aperture and a viewing path having at least one additional objective aperture wherein the objective aperture through which light passes through only a portion is in the illumination path.

Claim 28 has been amended as follows:

28. (Amended) The method of claim 22 wherein the imaging system is a light microscope having an illumination path including ~~at least one~~ the objective aperture and a viewing path having at least one additional objective aperture wherein the objective aperture through which light passes through only a portion is in the viewing path.

Claim 32 has been amended as follows:

32. (Amended) The method ~~os~~ of claim 22 wherein the microscope is a phase contrast microscope.